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“Petroleum Provinces of the 21st Century”
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Australian Petroleum Provinces of the 21st Century

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The Australian hydrocarbon exploration effort dates back to the 19th century but it was not until well into the 20th Century that the first commercial field was discovered (Moonie, 1962). The cumulative result of only some 3500 exploration wells drilled in 40 different basins within Australia has resulted in the discovery of an estimated 10.8 billion bbls of liquids (oil, condensate and LPG) and 112 tcf of gas reserves. The majority of these hydrocarbon reserves (~70%) are within the Gippsland, Cooper/Eromanga and the Carnarvon, Browse and Bonaparte basins of the Northwest Shelf.

The Cooper/Eromanga and Gippsland Basins are mature exploration provinces with modest future exploration potential, but the massive discovered and undeveloped reserves within the major gas fields along the NW Shelf will be developed (principally for LNG export) and fuel adjacent exploration activity well into the 21st Century. The NW Shelf still has significant potential for further major discoveries as demonstrated by its undrilled identified prospectivity.

Other basins which offer the potential to develop into significant petroleum provinces in the 21st Century include the basins of the Great Australian Bight and the Lord Howe Rise which have been largely overlooked during the 20th Century due to the then perceived excessive water depths and relatively isolated locations. These areas offer some of the best potential for undiscovered oil provinces and are the focus of current and future gazettal round opportunities.

Editor’s Note –

Part 1 of this paper was not available at the time we posted this Preprint CD-ROM, so we attach here the images in PDF form. The complete paper will be published in the subsequent volume, AAPG Memoir 73, later in 2000. We regret this inconvenience.

Australian Petroleum Provinces of the 21st Century

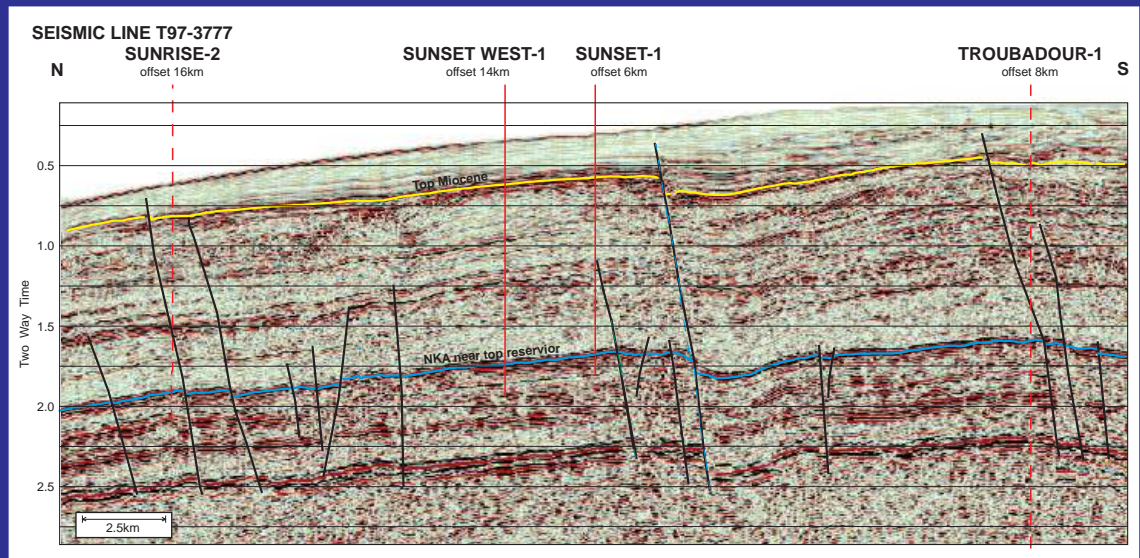
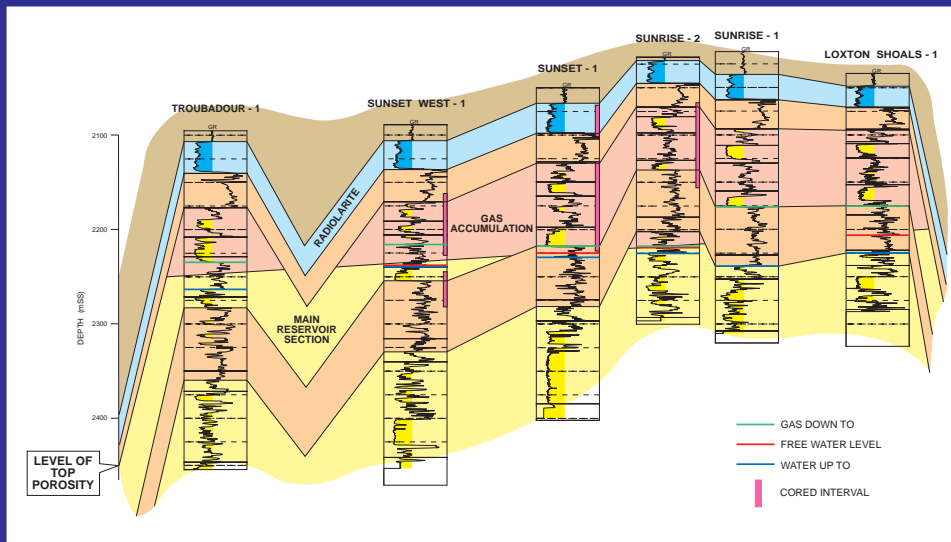
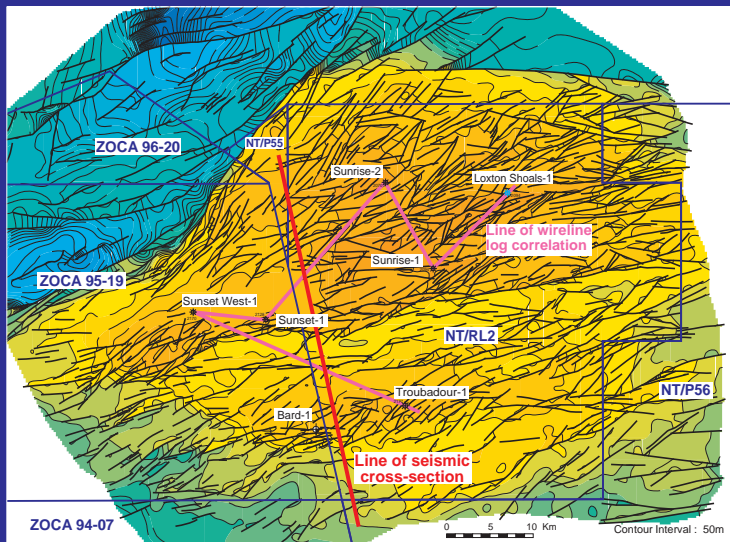
Ian M. Longley, Marita T. Bradshaw, and John Hebbberger

Part 2

FIGURE LIST

Part 2

11. Sunrise Troubadour Field Summary
12. Brecknock Field Summary
13. Scarborough Field Summary
14. Chysaor/Dionysis Field Summary
15. Bayu-Undan Field Summary
16. Southern margin regional map
17. Great Australian Bight regional sections
18. Seismic line from the outer Ceduna Sub-basin (DWGAB Survey) showing decollement within the Late Cretaceous (Tiger supersequence) overlying a deformed ?Cenomanian (White Pointer succession) (from Totterdell et al in prep. Fig 12.)
19. Closely-spaced planar faults within the Late Cretaceous (Hammerhead supersequence), southern Ceduna Sub-basin (DWGAB Survey) (from Totterdell et al in prep. Fig 13.)
20. Eastern margin regional map including gas hydrates, GBRMP, South Tasman Rise
21. BSR and flat spot in horst from Lord Howe Rise from Exon et al 1998 Fig. 5
22. Eastern margin palaeogeographic map
23. Structural elements maps for the LHR region from Stagg & Wilcox in prep.



PERMIT: NT/RL2 & ZOCA 95-19
 Woodside 66.6 - 34.3%, Phillips 8.33 - 33.3%, Shell 25.0 - 32.3%
DISCOVERY: Sunrise-1, Troubadour-1
YEAR OF DISCOVERY: 1974
NO. OF WELLS ON FIELD: Sunrise: 5, Troubadour: 1
RESERVOIR: Mid Jurassic (Bathonian-Callovian) Sands. *C. torosa* – *W. digitata*
TRAP: Faulted anticline (Neogene age of formation)
SEISMIC COVERAGE: 2D : 1 x 3 km grid
AREA EXTENT: ~1100 km²
VERTICAL CLOSURE: ~180m crest ~2050mSS deepest GWC = 2234mSS
AV POROSITY: 14%
RESERVOIR TEMP: 120°C
RESERVOIR PRESSURE: 3300psia

AV PERM: 90mD
CGR: 40 bbls/mmcf

GIIP: (tcf)	most likely	upside	
	13.0	18.5	
0.9	1.5	Troubadour	
	13.9	20.0	Total

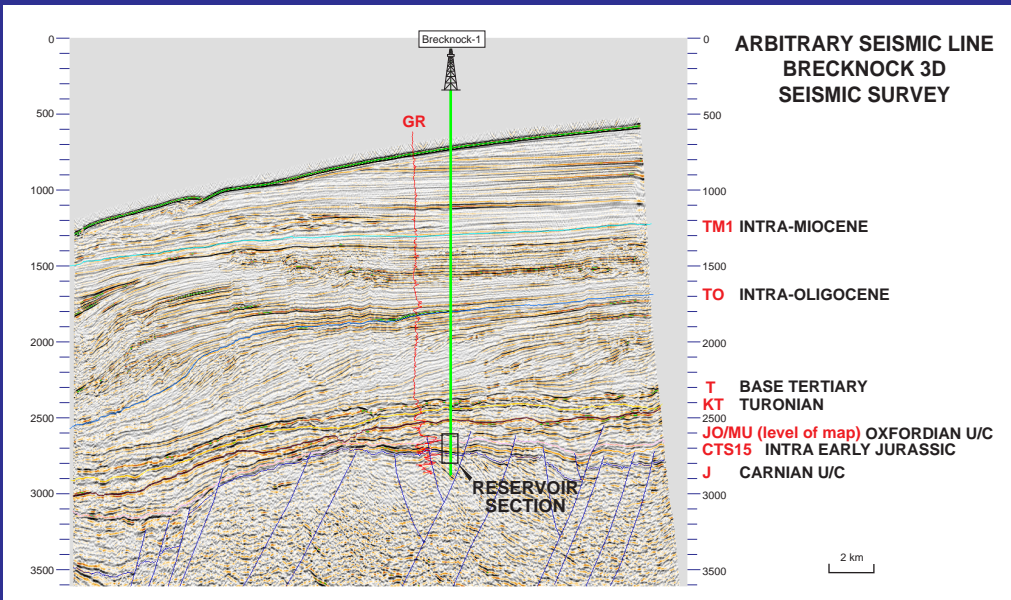
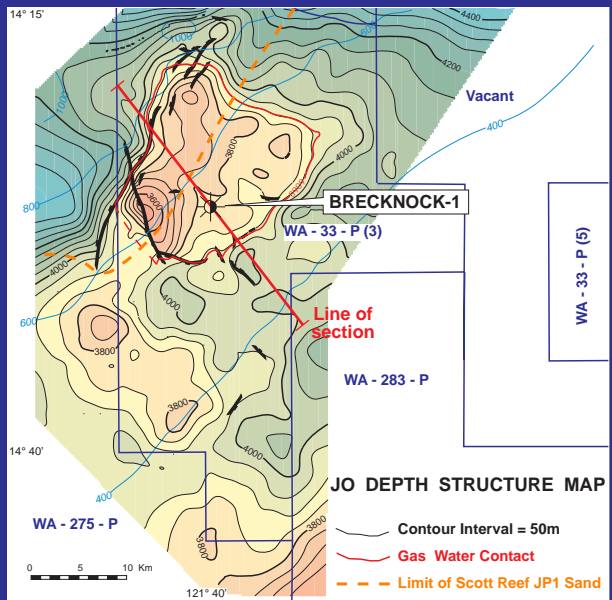
REC. Gas (tcf)	8.4	12.5	
	0.6	1.0	
	9.0	13.5	Total

REC. Condensate (mmbbls)	301	463	
	15	26	
	316	489	Total

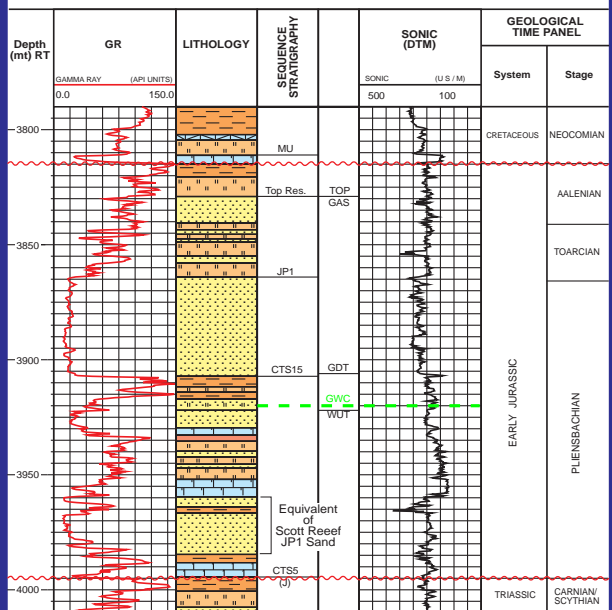
DISTANCE TO LANDFALL: 400 km
INDICATIVE GAS QUALITY: (mole %)

	C1	=	Sunrise	Troubadour
$\Sigma C1 - Cn$			87%	89%
CO ₂			4.5%	4.8%
N ₂			3.0%	2.4%

SUNRISE - TROUBADOUR SUMMARY



BRECKNOCK - 1 : RESERVOIR SUMMARY



NB: Attempted DST on gas interval abandoned due to equipment problems

--- GWC interpreted from RFT data

PERMIT: WA-33-P
 Woodside 50%, BP 16.7%, Chevron 6.7%,
 BHP 8.3%, Shell 8.3%

DISCOVERY: Brecknock-1

YEAR OF DISCOVERY: 1979

NO. OF WELLS ON FIELD: 1

RESERVOIR: Early Jurassic (Aalenian-Pleinsbachian) Sands
 C. torosa – C. turbatus sands

TRAP: Faulted anticline at Oxfordian Unconformity (JO/MU) level

SEISMIC COVERAGE: Brecknock Main 3D (1997 vintage)

AREA EXTENT: 320 km²

VERTICAL CLOSURE: 360 m

AV POROSITY: 19%

RESERVOIR TEMP:

RESERVOIR PRESSURE:

AV PERM: 10 - 90mD

CGR: 22 bbbls/mmcft

GIIP: most likely upside
 (tcf) 13.3 20.0

REC. Gas (tcf) 7.4 11.3

REC. Condensate (mmbbls) 123 190

DISTANCE TO LANDFALL: 230 km

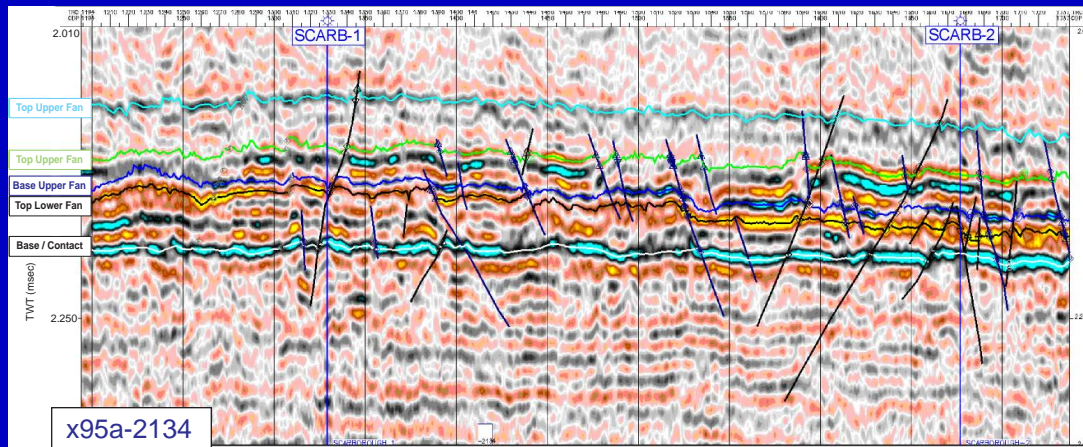
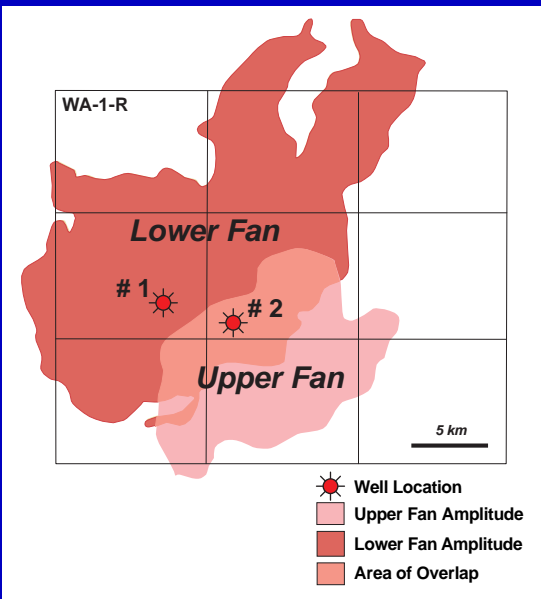
INDICATIVE GAS QUALITY: (mole %)

$$\frac{C1}{\sum C1 - Cn} = 89\%$$

$$CO_2 = 4.7\%$$

$$N_2 = 0.4\%$$

BRECKNOCK FIELD SUMMARY



PERMIT: WA-1-R
Esso 50%, BHPP 50%

DISCOVERY: Scarborough-1

YEAR OF DISCOVERY: 1979

NO. OF WELLS ON FIELD: 2

RESERVOIR: Lower Cretaceous (U.Berriasian)
Barrow Group lowstand fan sands

TRAP: Broad anticline

SEISMIC COVERAGE: 2D Seismic only

AREAL EXTENT: 350 km²

VERTICAL CLOSURE: 100 m

AV POROSITY: 26%

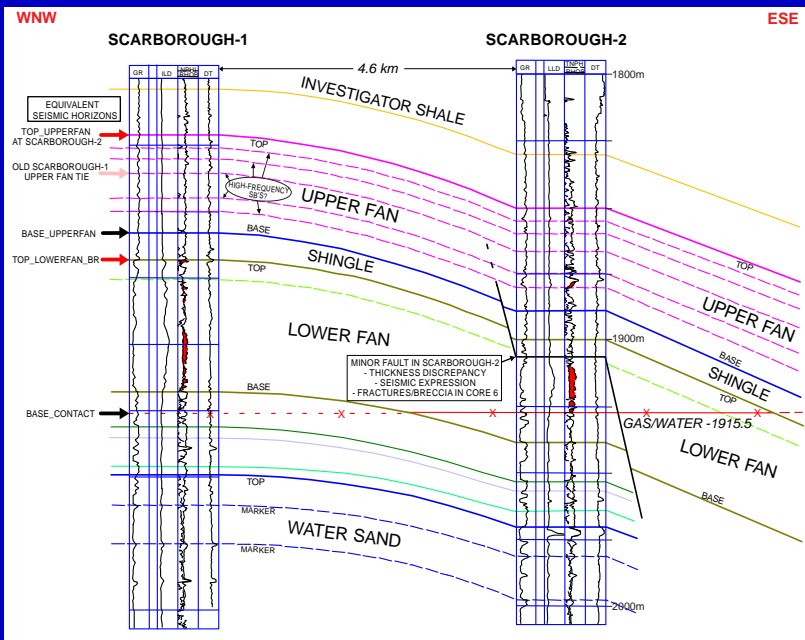
RESERVOIR TEMP: 45°C

RESERVOIR PRESSURE: 2820 psi

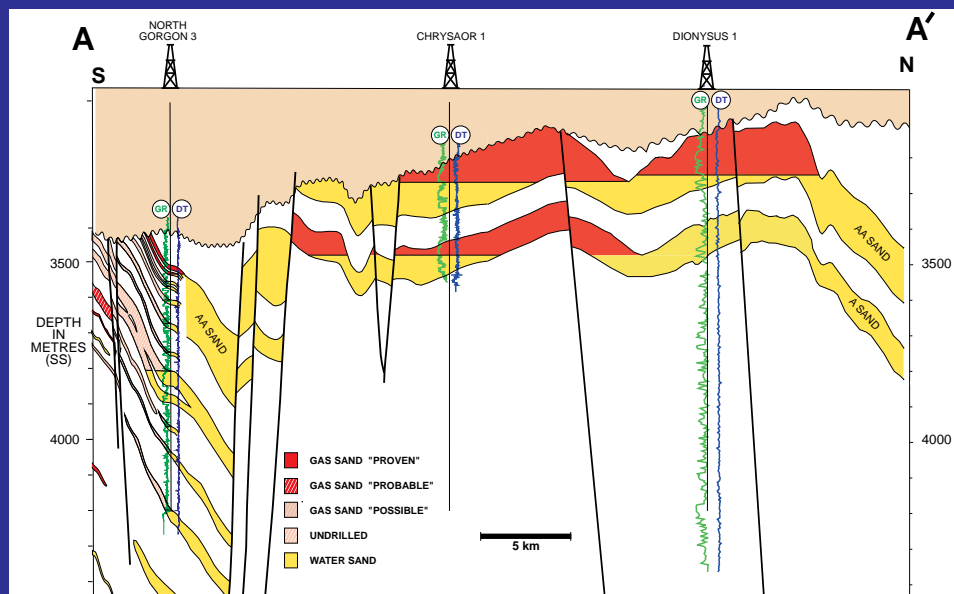
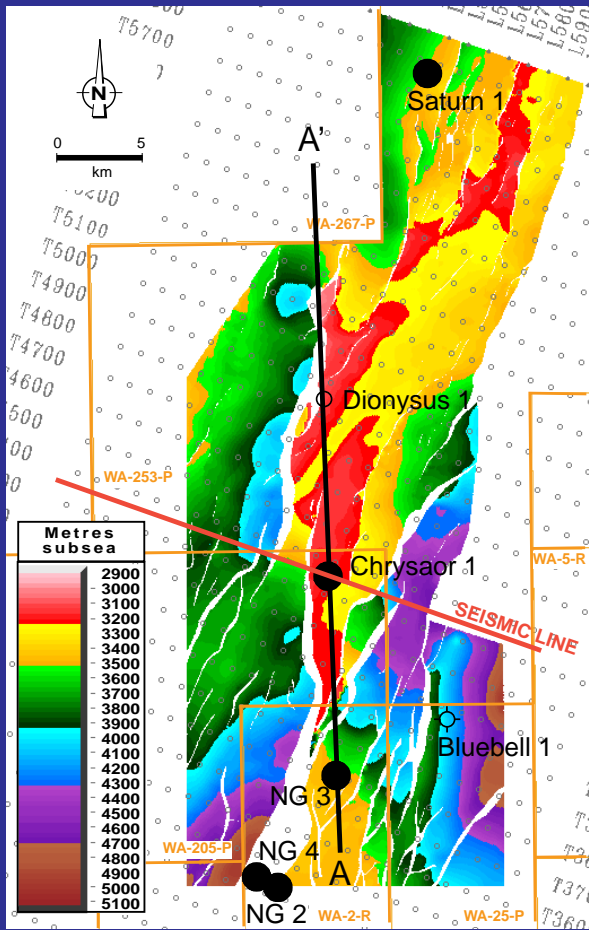
PERM: 1000-5000md (Lower Fan)

RESERVES: most likely 4.0* upside 4.8* * Industry estimate
(tcf)

GAS COMPOSITION: C₁ = 96%
N₂ = 4%



SCARBOROUGH FIELD SUMMARY



PERMITS: WA-253-P (Chevron 50%, Texaco 50%)
 WA-205-P (Chevron 28.6%, Texaco 28.6%,
 Shell 28.6%, Mobil 14.3%)

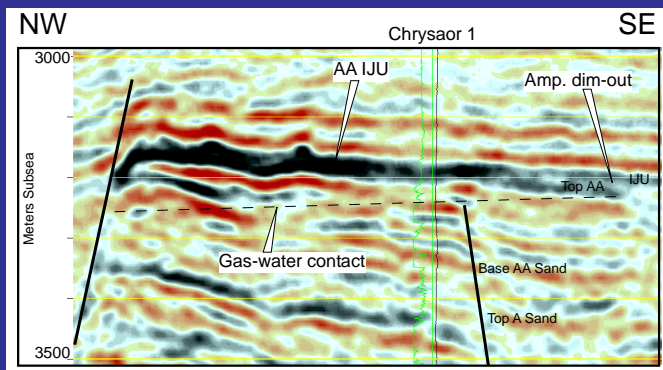
DISCOVERY: Chrysaor 1994, Dionysus 1996

NO. OF WELLS ON FIELD: 2

RESERVOIR: Triassic A Sand, AA Sand

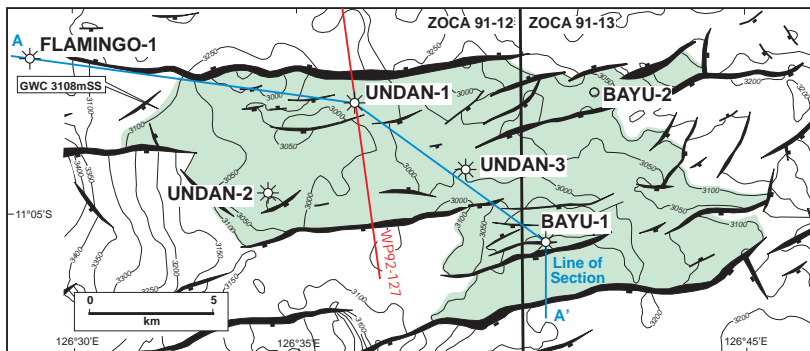
TRAP: Faulted anticline

SEISMIC COVERAGE: 3D

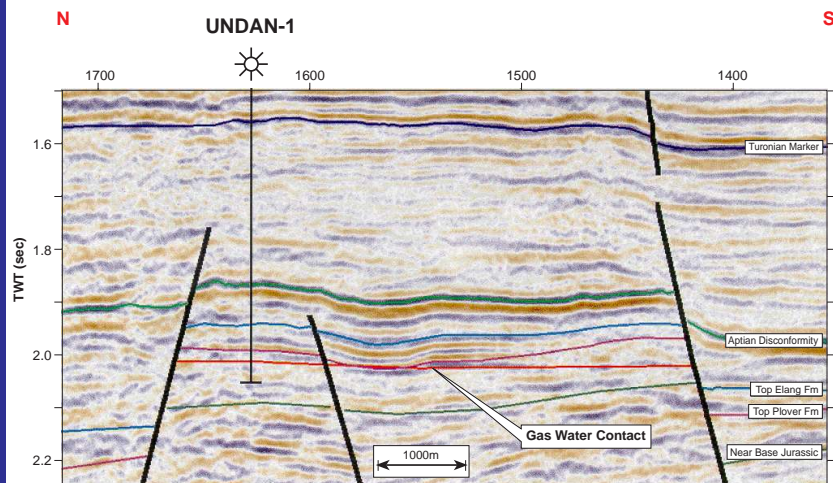


	Chrysaor		Dionysus	
	most likely	upside	most likely	upside
GIIP (tcf)	3.1	3.6	2.5	2.9
REC. Gas (tcf)	2.2	2.5	1.8	2.1
REC. Condensate (mmbbls)	23.4	26.0	16.1	18.4
CGR (bbls/mmscf)	13.9		11.7	
INDICATIVE GAS QUALITY: (mole %)				
Ch4 / (CH4-CnHn) ratio	92		93	
CO2	10.8		9.1	
N2	4.4		3.2	

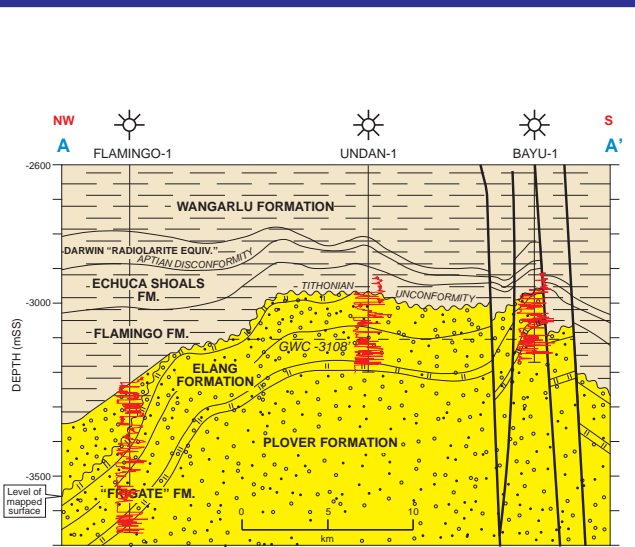
CHRYSAOR / DIONYSUS SUMMARY



TOP CALLOVIAN SAND DEPTH MAP
(AT END 1995)



SEISMIC LINE WP92-127 THROUGH UN DAN-1



GEOLOGICAL CROSS-SECTION THROUGH
FLAMINGO-1 AND THE BAYU-UN DAN FIELD

PERMITS: ZOCA 91-12 (Phillips 42.42%, Santos 21.42%,
Inpex 21.21%, Petroz 13.37%,
Emet 1.57%)
ZOCA 91-13 (Phillips 60%, Oryx 25%,
British Borneo 15%)

DISCOVERY: 1984

NO. OF WELLS ON FIELD: 10

RESERVOIR: Middle Jurassic (Elang / Plover) Sands
R.aemula - D.complex sands

TRAP: Faulted anticline

SEISMIC COVERAGE: 3D (1996)

AREA: 170 km² (based on displayed map)

VERTICAL CLOSURE: 170m

AV POROSITY: 10%

RESERVOIR TEMP: ~130°C

RESERVOIR PRESSURE:

AV PERM: -

CGR: 65 bbls/mmcf

GIIP: most likely upside
(tcf) 6.2 7.0

REC. Gas
(tcf) 3.4 4.1

REC. Condensate
(mmbbls) 229 289

LPG
(mmbbls) 175 219

DISTANCE TO LANDFALL: 300km

INDICATIVE GAS QUALITY: (mole %)

$$\frac{C1}{\sum C1 - Cn} = 78\%$$

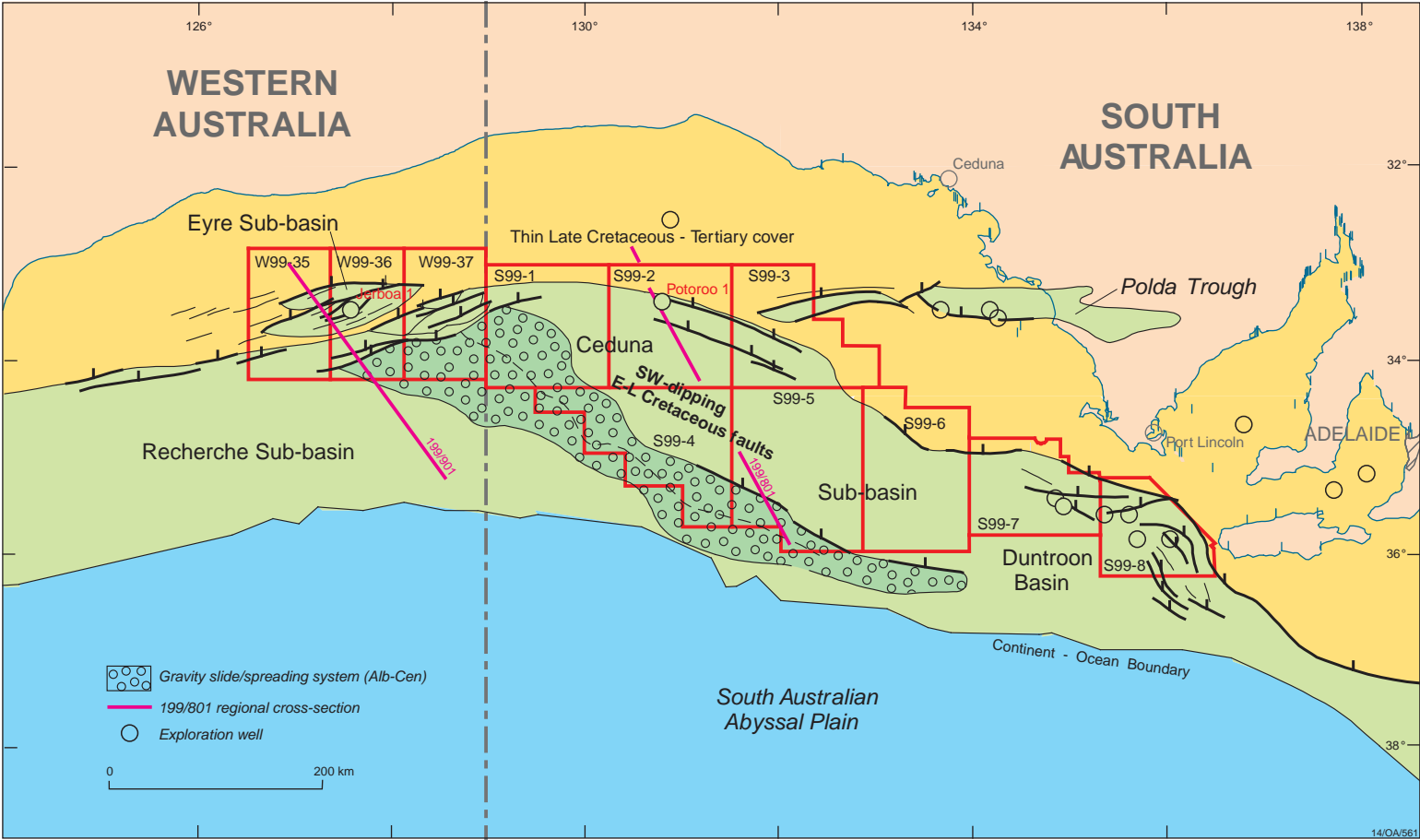
$$CO_2 = 5.4\%$$

$$N_2 = 3.4\%$$

BAYU - UN DAN SUMMARY

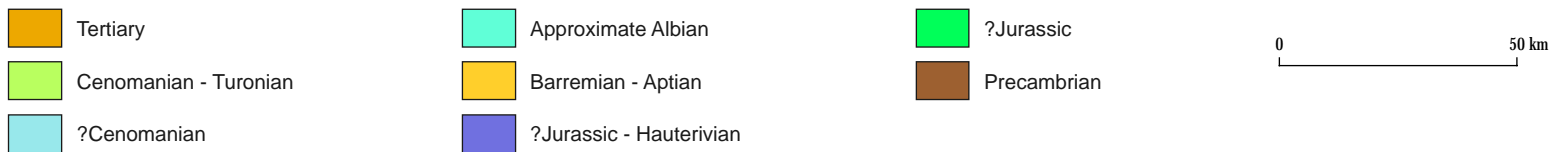
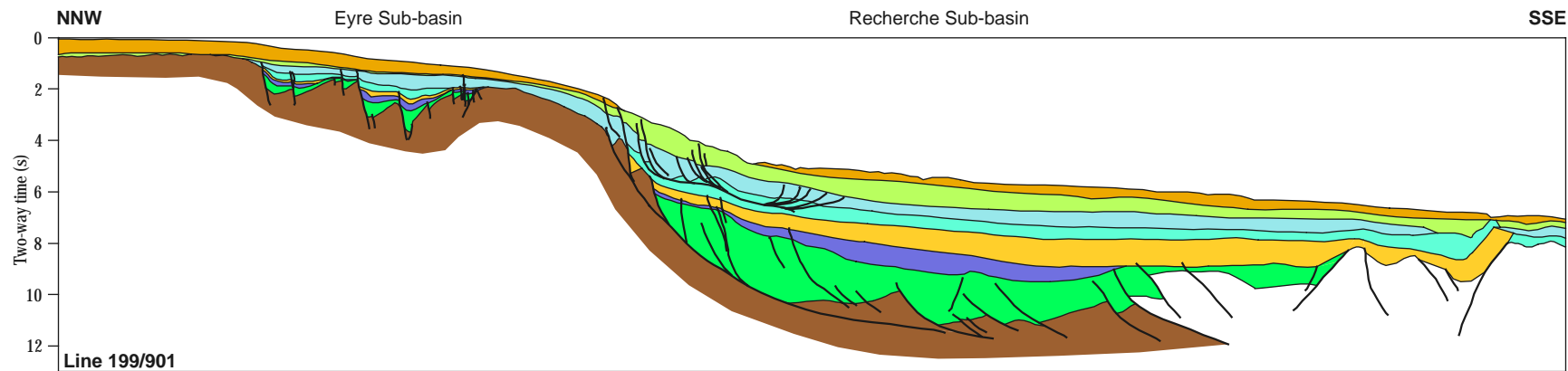
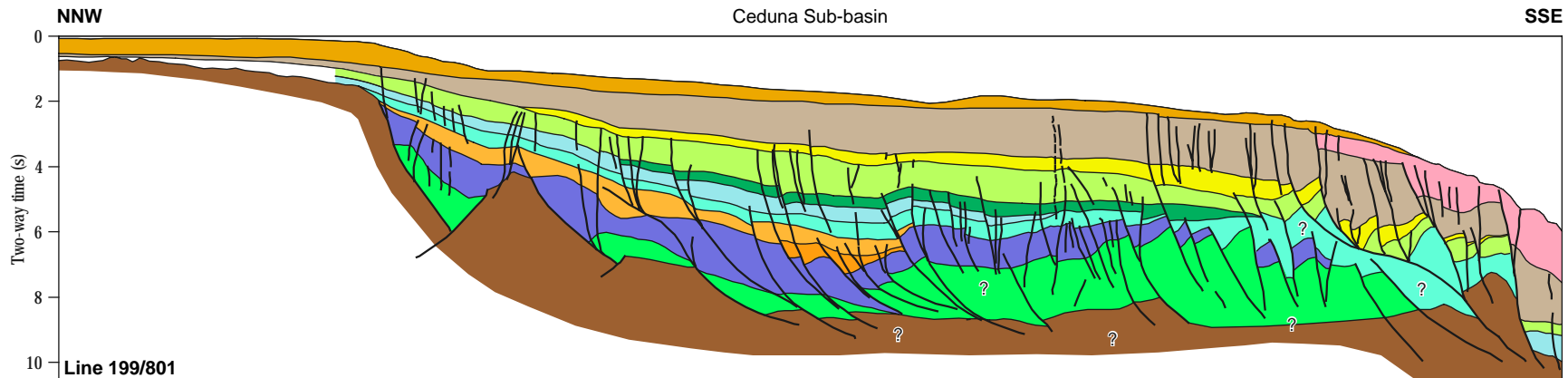
WESTERN AUSTRALIA

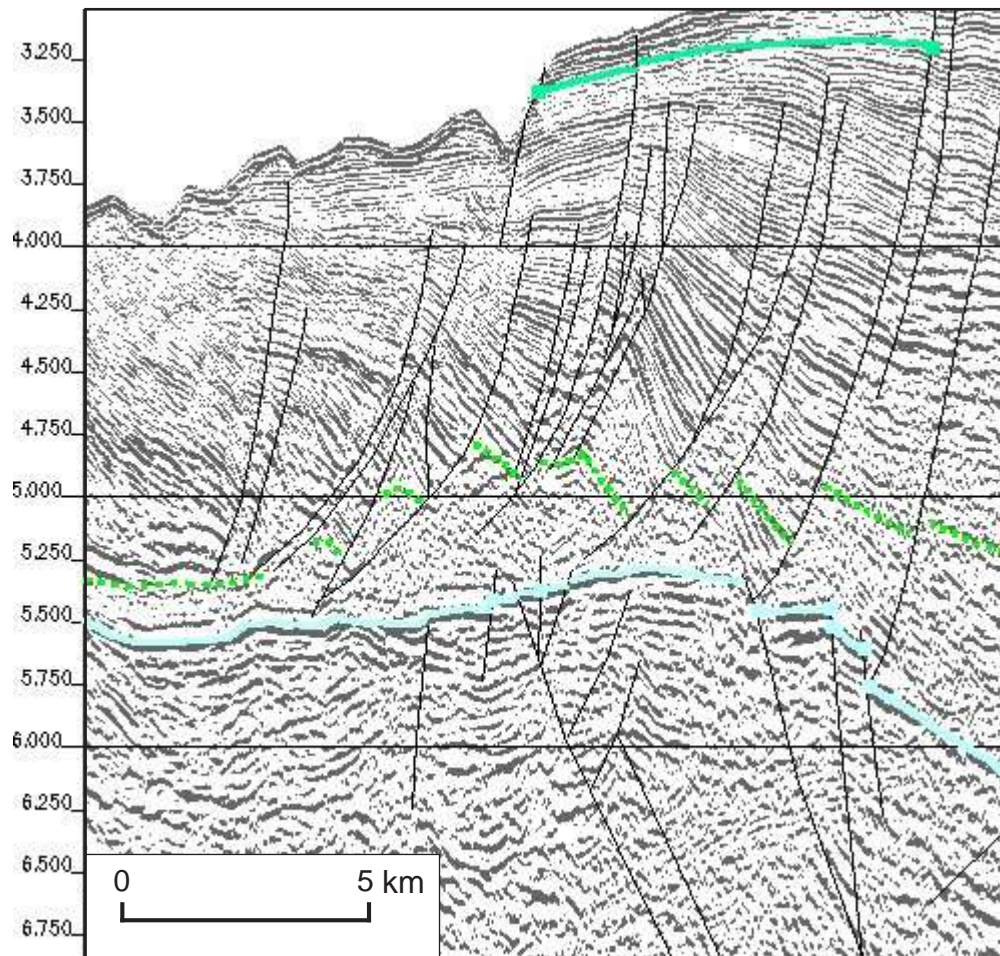
SOUTH AUSTRALIA



- Gravity slide/spreading system (Alb-Cen)
- 199/801 regional cross-section
- Exploration well

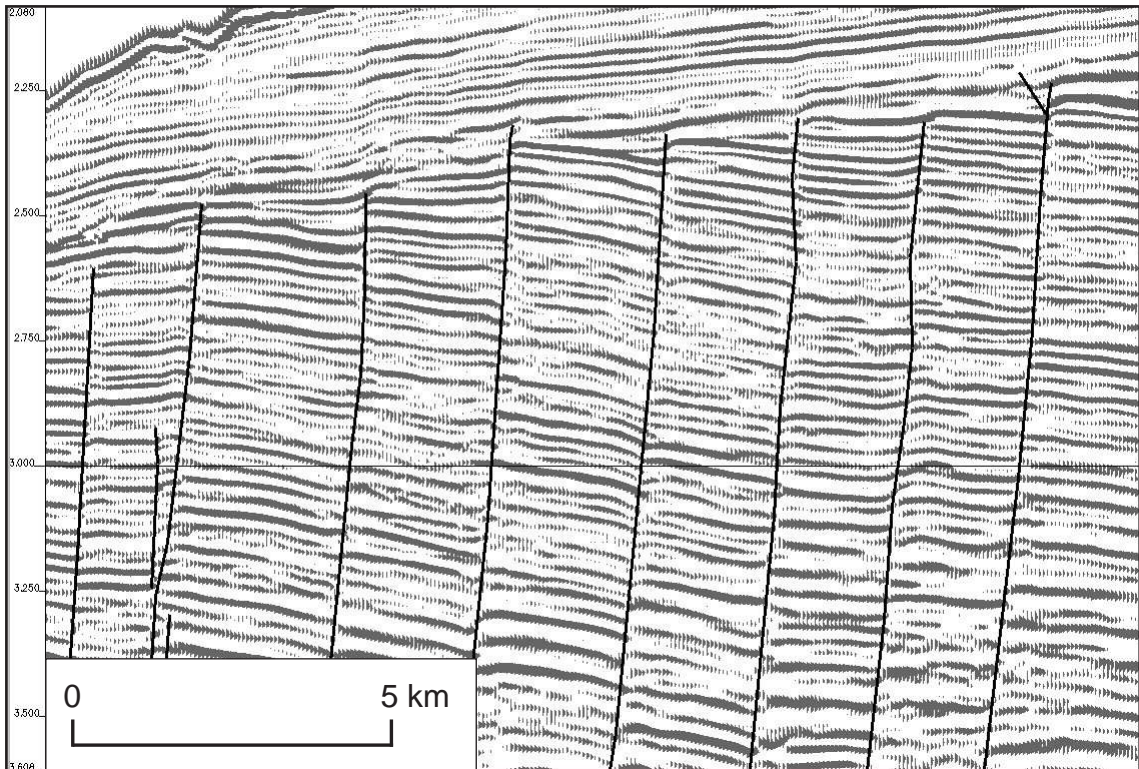


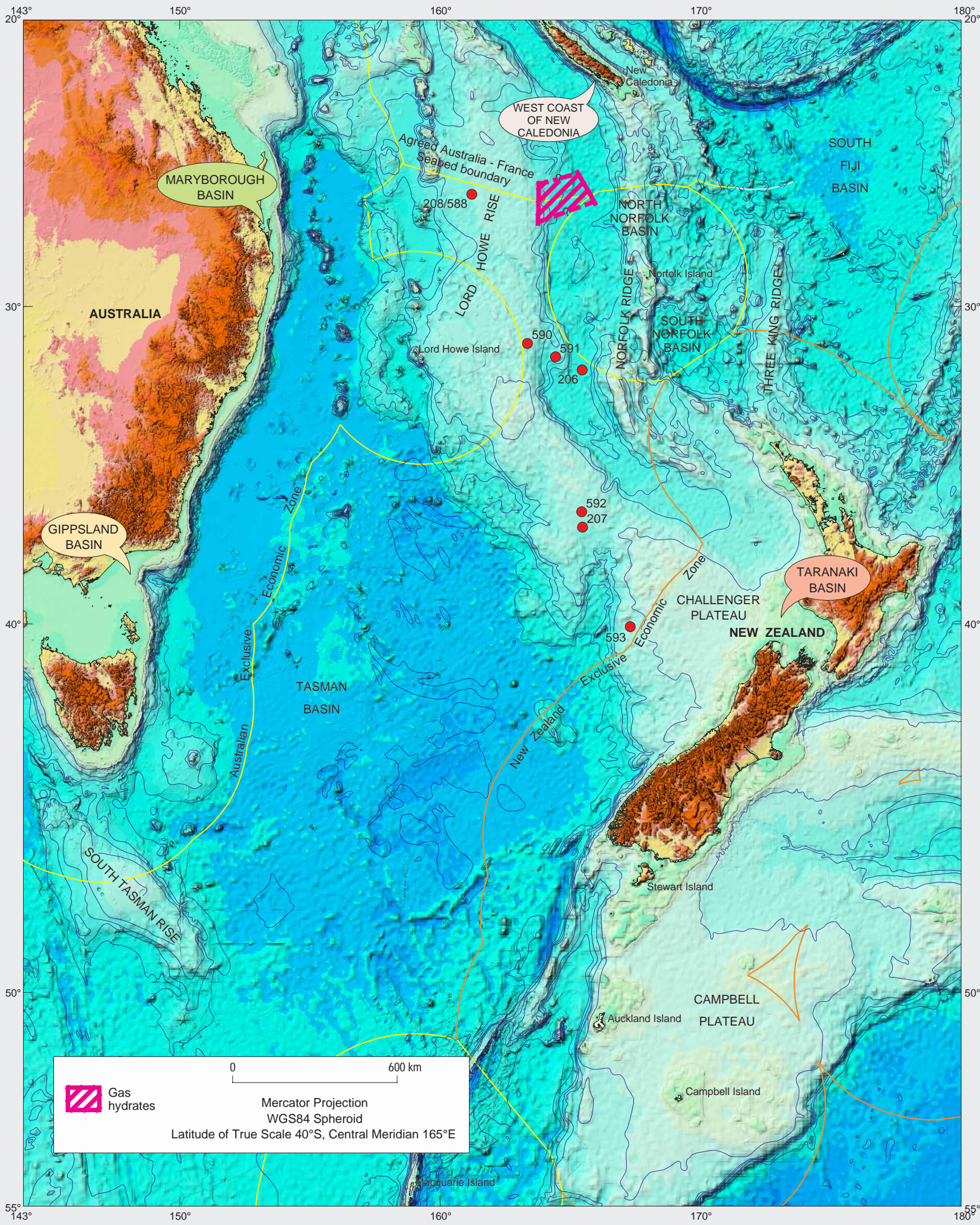


SW**NE**

SW

NE





WEST COAST OF NEW CALEDONIA

MARYBOROUGH BASIN

SOUTH FIJI BASIN

AUSTRALIA

NORTH NORFOLK BASIN

SOUTH NORFOLK BASIN

GIPPSLAND BASIN

LORD HOWE RISE

THREE KING RIDGE

TARANAKI BASIN

Economic Zone

Economic Zone

Exclusive Australian

Exclusive New Zealand

TASMAN BASIN

CHALLENGER PLATEAU

NEW ZEALAND

SOUTH TASMAN RISE


Stewart Island


CAMPBELL PLATEAU

Auckland Island

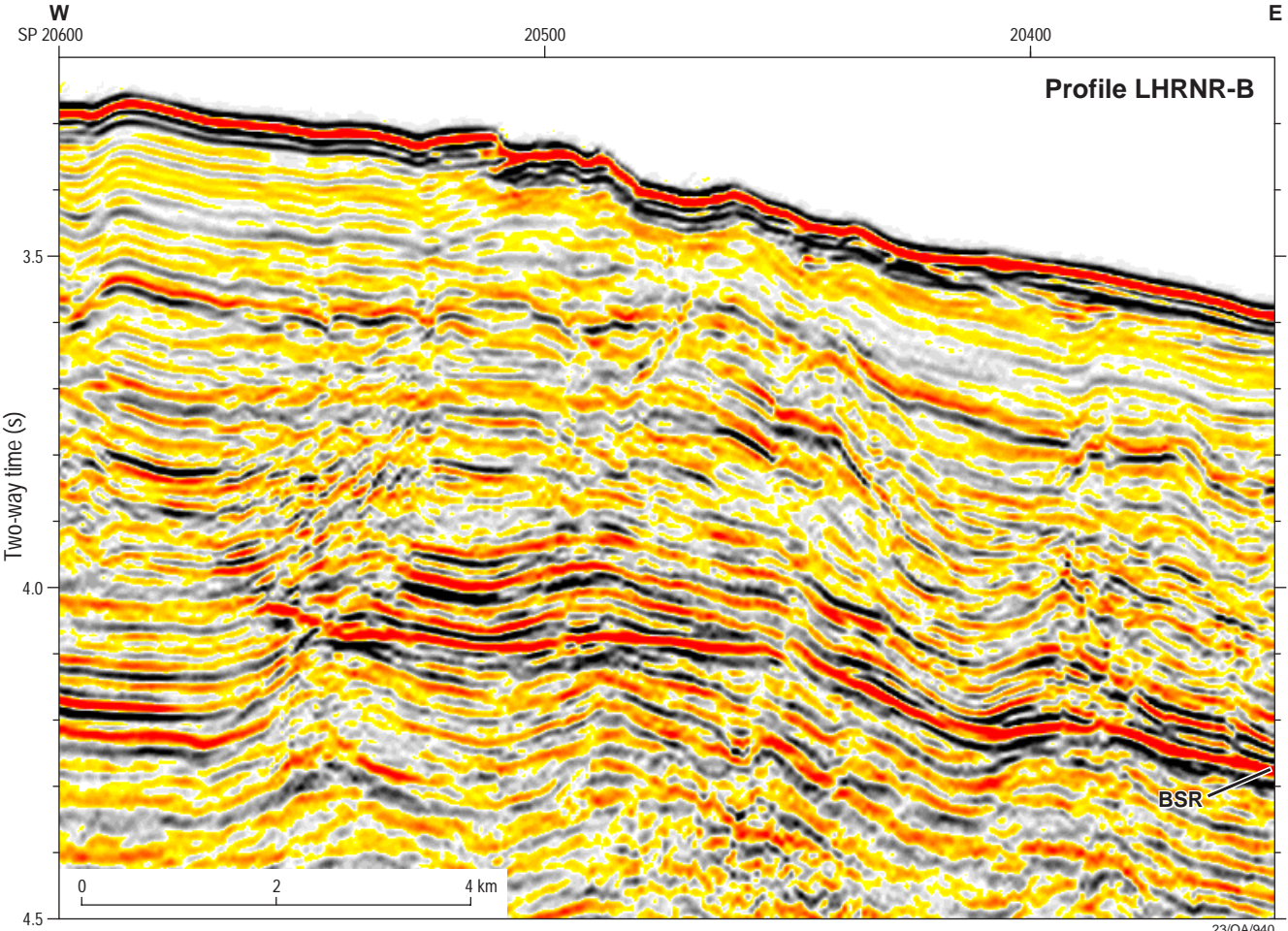
Campbell Island

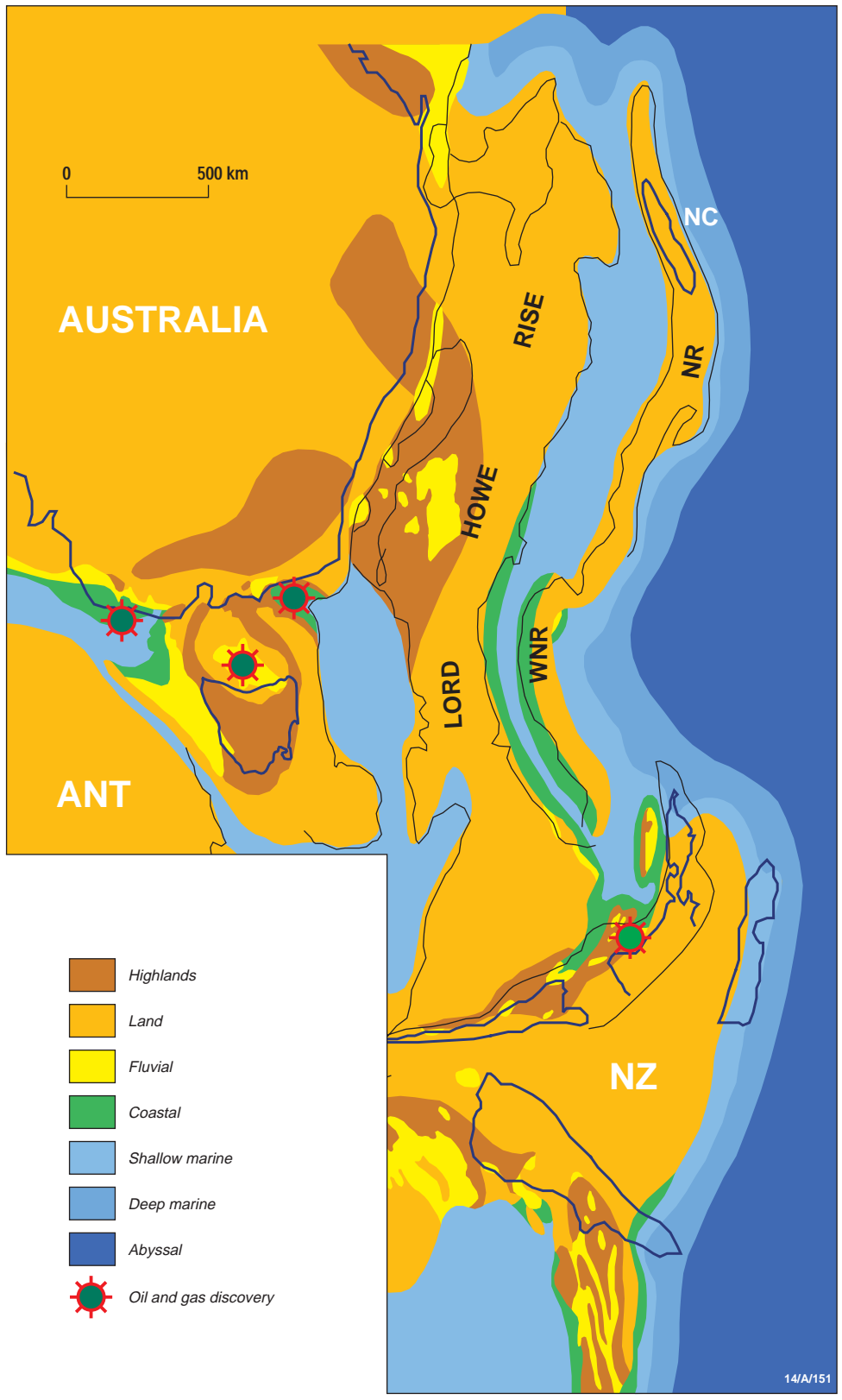
Jacquarie Island

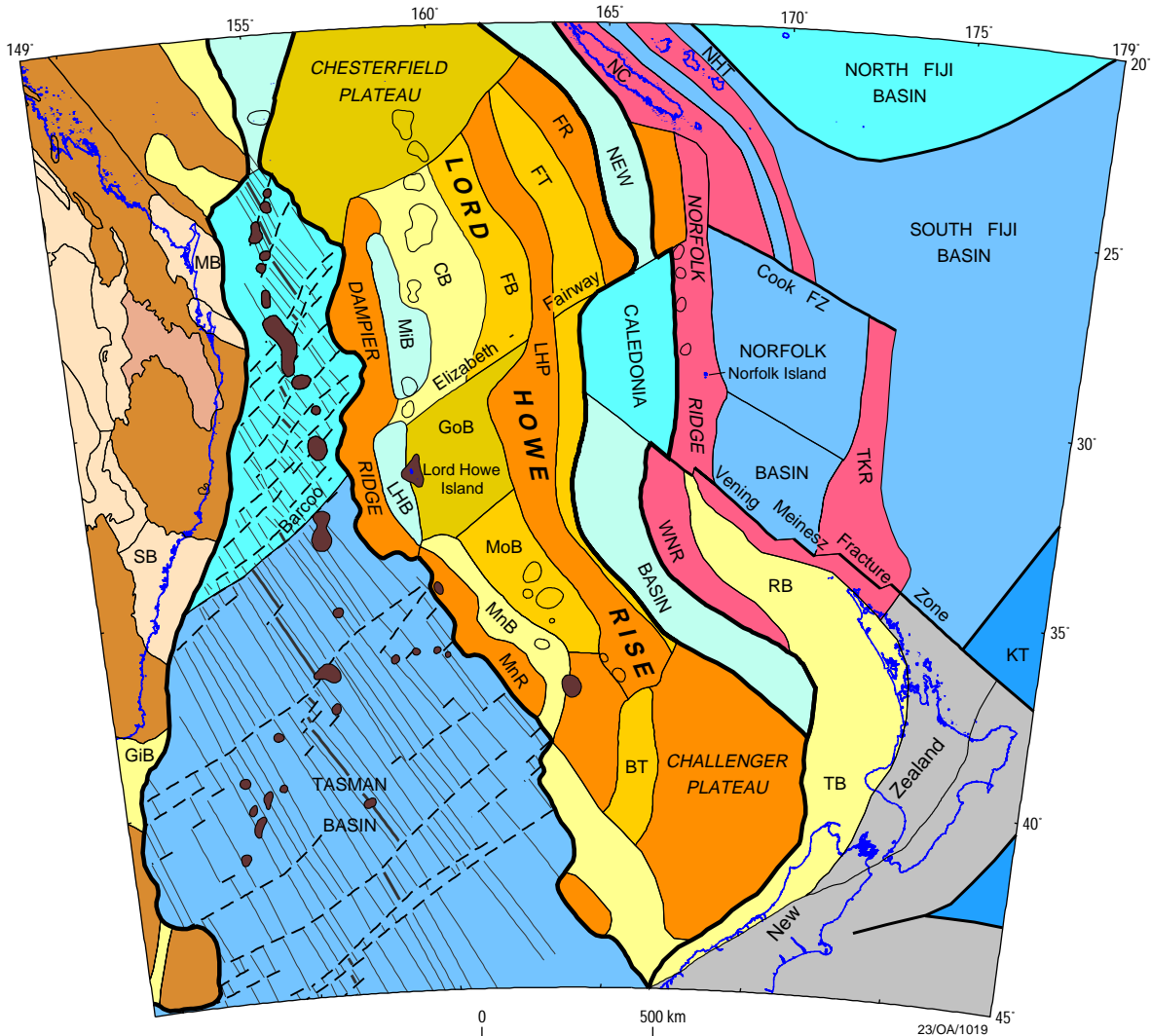
 Gas hydrates



Mercator Projection
 WGS84 Spheroid
 Latitude of True Scale 40°S, Central Meridian 165°E







● *Volcanics*

BT Bellona Trough
 CB Capel Basin
 FB Faust Basin
 FR Fairway Ridge
 FT Fairway Trough
 GiB Gippsland Basin

GoB Gower Basin
 KT Kermacec Trench
 LHB Lord Howe Basin
 LHP Lord Howe Platform
 MB Maryborough Basin
 MIB Middleton Basin
 MnB Monawai Basin
 MnR Monawai Ridge

MoB Moore Basin
 NC New Caledonia
 NHT New Hebrides Trench
 RB Reinga Basin
 SB Sydney Basin
 TB Taranaki Basin
 TKR Three Kings Ridge
 WNR West Norfolk Ridge

BASIN	Age	Petroleum supersystem	No. exploration wells	Historical HC discovery success rate	No HC Discoveries	oil status -	gas status	Discovered Volumes at 1.11.99				Developed Volumes at 1.1.98				Undiscovered Estimates	
								Oil (mmbbls)	Condensate (mmbbls)	LPG (mmbbls)	Gas (Tcf)	Oil (mmbbls)	Condensate (mmbbls)	LPG (mmbbls)	Gas (Tcf)	oil mmbbl (P50)	gas TCF (P50)
McArthur	Mesoproterozoic		6		0	shows										not assessed	not assessed
Amadeus	Neoproterozoic-Devonian	Centralian, Larapintine	29	17%	5	production	production	19	6.6	4.1	0.8	19	6.4	3.3	0.5	30	0.13
Arrowie	Cambrian	Larapintine	1		0	shows										not assessed	not assessed
Arafura	Cambrian-Triassic	Larapintine	12		0	recovery										4	0.01
Ngalia	Cambrian- Carboniferous	Larapintine	2	50%	1		flow									2	0.006
Adavale	Devonian-Carboniferous	Larapintine	11	9%	1		production	0	0	0	0.02	0	0	0	0.02	not assessed	0.2
Canning - onshore	Ordovician-Cretaceous	Larapintine	164	6%	10	production	flow	3.8	0	0	0	3.8	0	0	0	19	
Officer	Neoproterozoic-Permian	Larapintine	12		0	shows	shows									not assessed	not assessed
Georgina	Neoproterozoic-Ordovician	Larapintine	6	17%	1	shows	flow									1	
Bonaparte	Cambrian-Recent	Larapintine, Gondwanan, Westralian	249	16%	41	production	undeveloped giant fields	528.0	170.5	116.3	7.9	171.6	0	0	0.07	520	2.4
Perth	Silurian-Recent	Gondwanan, Austral	129	12%	16	production	production	4.2	1.4	0	0.7	4.2	1.4	0	0.7	140	0.4
Tasmania	Permian	Gondwanan	11		0	past oil shale production	shows									not assessed	not assessed
Sydney	Permian-Triassic	Gondwanan	39	3%	1	past oil shale production	coal bed methane									0.1	0.004
Cooper/Eromanga	Carboniferous-Cretaceous	Gondwanan, Murta	933	36%	336	production	production	267.5	134	173.2	8.4	266.9	105.1	153.5	6.4	68	0.8
Bowen/Surat	Permian-Cretaceous	Gondwanan	815	19%	151	production	production	32.7	7.8	9.9	0.7	32.7	7.7	9.8	0.6	6	0.25
Clarence Morteon	Triassic-Cretaceous	Murta	14		0		shows									0.4	0.03
Pedirka	Jurassic-Cretaceous	Murta	16		0	shows										1.5	0.03
Gippsland	Cretaceous-Recent	Austral	314	15%	48	production	production	3974.6	262.4	662.3	12.1	3797.2	238.4	654.8	9.4	180	0.7
Bass	Cretaceous-Recent	Austral	28	7%	2	flow	flow	15.4	34.7	51.2	0.3	0	0	0	0	10	0.16
Otway	Jurassic-Recent	Austral	156	16%	25	flow	production	0	2.5	0	0.52	0	0.5	0	0.08	100	1.8
Dunroon	Jurassic-Recent	Austral	3		0	recovery										16	0.06
Eyre	Jurassic-Recent	Austral	1		0	show										not assessed	not assessed
Carnarvon	Silurian-Recent	Westralian	397	23%	92	production	production	1563.9	1075.7	828.6	70.9	1030.3	707.3	591.9	24.4	585	21
Offshore Canning	Devonian-Recent	Westralian	13		0		shows									66	0.6
Browse	Permian-Recent	Westralian	58	12%	7	flows	undeveloped giant	13.0	424.9	742	33.7	0	0	0	0	160	4
Total			3419	22%	737			6422.1	2120.5	2587.6	136.0	5325.7	1066.8	1413.3	42.2	1909	32.6

ERA	Supersystem	sub-unit	age	source facies	formation names	distribution - basin	key discoveries	analog
Proteroz.	McARTHUR evaporitic rifts		Mesoproterozoic 1700 - 1500 Ma	lacustrine dol. shales	Barney Creek	McArthur, Mt Isa, eastern Arafura?	oil & gas shows	none
	URAPUNGAN marine shelf and slope, foreland basin		Mesoproterozoic c. 1400 Ma	marine shales	Velkerri & McMinn	McArthur, Mt Isa, Victoria River	oil flows - BMR Urapunga 4, Jamieson 1	none
	CENTRALIAN Centralian Superbasin - intracratonic basin within Rodinia marine, evaporitic, glacial	1 2 3	Neoproterozoic c. 750 Ma Neoproterozoic c. 650 Ma Neoproterozoic c. 600 Ma	carbonates, evaporites shales post glacial marine shales post glacial marine shales	Bitter Springs, Albinia Browne Aralka, Rinkabeena Pertatataka, Rodda	Amadeus, Ngalia, Georgina Officer, Birrindudu, Savory Amadeus, Georgina Ngalia Amadeus, Officer, Ngalia Savory, Victoria River	gas flow Magee 1 oil & gas shows gas flows - Ooraminna 1 Davis 1 Dingo gas field	Siberia Oman
Pz	LARAPINTINE lower Palaeozoic tropical climate carbonates, evaporites, marine clastics	1 2 3 4	Cambrian Ordovician Middle-Late Devonian Early Carboniferous	marine calc. shale marine marine carbonate marine anoxic shale	Goulburn Gp., Tempe Horn Valley, Goldwyer Gogo, Ningbing Anderson, Milligans	Arafura, Amadeus Amadeus, Canning Canning, Bonaparte Canning, Bonaparte	Arafura 1 oil shows Mereenie oil field Blina oil field Sundown oil field	Williston Bolivia
	GONDWANAN Late Carb.- Early Triassic glaciation, clastics higher plant contribution to source rocks	1 2 3	Early Permian Late Permian earliest Triassic	non-marine marine non-marine marine deltaic marine	Irwin River,Patchawarra Treachery, Keyling Blackwater Gp. Wagina Hyland Bay Kockatea	Perth, Cooper, Bowen Bonaparte Bowen Perth Bonaparte Perth	Tirrawarra gas & oil field Rolleston gas field Petrel gas field Dongara oil & gas field	
	WESTRALIAN Traissic-Cenozoic Break-up of northern and western margin marine rift environments	1 2 3 4 SAHUL	Late Trias.-E/M Juras. Late Jurassic Early Cretaceous Mesozoic	deltaic marine, anoxic? marine marine carbonate	Mungaroo Dingo, Flamingo Echuca Shoals	Carnarvon Carnarvon, Bonaparte Bonaparte, Browse Bonaparte, Timor, Seram	Rankin Trend giant gas fields Barrow Island oil field Undan/Bayu; Cornea?	North Sea
Mz	AUSTRAL Late Jurassic-Cenozoic Break-up of southern and south-western margins terrestrial rift environments	1 2 3	Late Jur.- Early Cret. Early Cretaceous Late Cretaceous	fluvio-lacustrine shale fluvial - coaly fluvio-deltaic	Casterton, Pretty Hill, Parnelia Eumeralla Latrobe Gp.	Otway, Perth, Carnarvon? Otway Gippsland, Bass	Katnook, Gage Roads Windermere, Minerva Kingfish	
	MURTA Cretaceous interior sag, fluvio-lacustrine to marine	1 2 3	Late Jurassic Neocomian Late Albian	fluvio-lacustrine lacustr./marginal marine anoxic marine oil shale	Poolawanna, Birkhead Murta Toolebuc	Eromanga, Surat Eromanga Eromanga	? oil shows unproven source Dullingari oil field oil shows, immature source	
	CAPRICORN Late Cret.-Cz rifts, northeast Aust., tropical Break-up of Coral Sea		Eocene	lacustrine oil shales			Stuart oil shale demonstration plant	SE Asia